

Attachment 4

Utah Pit Closure Sampling and Analytical Testing Procedures

The purpose of this attachment is to provide guidance to assist the operator in the collection and analysis of soil/sludge or water samples taken from pits used in association with oil and gas drilling and production. Additional information and guidance is available from UDOGM in the Environmental Handbook, Version 1.0 and the EPA (SW-846 – the official compendium of analytical and sampling methods).

Sampling will be subject to the following procedures and standards:

Pit water contents

- a. Generally, the fluid contents of the reserve pit are removed and transported to an approved disposal facility shortly after drilling and completion activities have ceased. However, some reserve pits remain open due to the well not being drilled, being shut in waiting on a gas pipeline, proposed deepening, etc.

Pre-treatment

- a. One water sample and one soil composite grab sample will be taken from each pit by the operator's contractor, or trained personnel, according to EPA and UDEQ's Water Quality Division approved sampling and testing standards and methods, which can be accessed at the following links:

<http://www.epa.gov/osa/fem/methcollectns.htm>

http://www.waterquality.utah.gov/Monitoring/docs/2006/06_DWQ_monitoring_manual.pdf

A "composite grab sample" is defined as soil samples taken from different locations within the pit, with the equal volume aliquots per location being combined into a single sample. The samples may be collected using a backhoe, drill rig, hand auger, shovel, or other means. The composite sample shall be comprised of soil samples from a minimum of four locations within the pit. Additional sample points may be required dependent on impoundment size and type. A stainless steel probe or hand auger is generally used to remove the soil sample from different depths of the pit. The soil samples, taken from each location in the pit, are combined into a single composite grab sample. At the discretion of the authorized officer, the sampling depth may be increased if there is suspicion that the fluid pit contents have infiltrated, or there are sensitive receptors nearby, such as shallow ground water table or riparian areas.

- b. Dependent on the size of the pit, more than one composite sample may be required. The rule of thumb is one composite sample for every 400 cubic yards of petroleum contaminated soil or sludge. Generally this is equivalent to one composite sample taken for every 50' x 50' area (5' deep), larger pits should be

divided into cells. Approximately 5-10 samples should be collected in a random S pattern for each cell. Smaller pits can be sample from each corner and one from the center. Samples should be collected from pit contents from surface to the bottom of pit.

- c. An accurate, written chain-of-custody shall be kept and submitted to the AO, along with copies of all laboratory test results as soon as they are available.

Post-treatment (Solidification)

- a. Samples will be collected from pits requiring solidification. One representative sample of the solidified matrix (monolith) will be taken from each pit by the operator's contractor.
- b. The sample will be reduced in size to pass a ¾ -inch sieve and be extracted utilizing the Utah Non-hazardous E&P Exempt Waste Revised Leachate Test Procedure.

Testing Parameters will utilize the following Methods (pre-treatment):

Contaminant sample testing must be conducted for the following constituents:

- Total Petroleum Hydrocarbons (TPH) [EPA Method 8015C for DRO and GRO]
- Benzene, Toluene, Ethyl-benzene, and Xylene (BTEX) [EPA Method 8021B or 8260B]
- Chlorides [EPA Method SW-846 9056/9253]
- pH [SW-846 9045D (solid waste), EPA 150.2 (liquid)]
- RCRA Metals (Ag, As, Ba, Cd, Cr, Hg, Pb, Se), along with Ca, Mg, and Na [EPA Method 3050B] if metals were used in drilling additives or derived from the geologic formations
- Salinity - EC [EPA Method 120.1]; ESP and SAR [Calculated] when proposed to be mitigated by landfarming
- Total Dissolved Solids (TDS) [EPA Method 160.1]

Testing Parameters will utilize the following Methods for Solidified Matrix (post-treatment):

Contaminant sample testing must be conducted for the following constituents using the Utah Non-hazardous E&P Exempt Waste Modified Leachate Test Procedure (see below):

- Total Petroleum Hydrocarbons (TPH) [EPA Method 1664]
- Benzene, Toluene, Ethyl-benzene, and Xylene (BTEX) [EPA Method 1311]
- Chlorides [EPA Method SW-846 9056/9253]
- pH [SW-846 9045D (solid waste), EPA 150.2 (liquid)]
- RCRA Metals [Utah Modified Leachate Test] if required
- Ca, Mg, and Na [EPA Method 3050B] if required
- Total Dissolved Solids (TDS) [EPA Method 160.1]

Analytical Concentrations and Applicable Treatment Technology:

Pits whose contents have been determined to be below the Tier 2 risk-based screening levels (RBSLs) from the pre-treatment analytical results will not require post-treatment sampling, e.g. a TPH of < 18,000 mg/kg (or ppm). This assessment will utilize the following formula for sites where both types of TPH, gasoline range organics (GRO) and diesel range organics (DRO), are detected, and the sum of the ratios of each hydrocarbon type must be calculated as follows:

$$\frac{X}{\text{GRO Tier 2 Value}} + \frac{Y}{\text{DRO Tier 2 Value}} = N$$

Where:

X = Detected GRO Concentration

Y = Detected DRO Concentration

N = Sum

Using the GRO and DRO Tier 2 values below any N value less than 1.0 would be acceptable for stabilization, whereas any N value greater than 1.0 would be considered an excessive risk and would require corrective action as determined by the AO.

Tier 2 Values

<u>TPH Type</u>	Residential			Non-Residential		
	<u>Soil</u> (mg/kg)	<u>Soil to GW</u> (mg/kg)	<u>Ground water</u> (mg/L)	<u>Soil</u> (mg/kg)	<u>Soil to GW</u> (mg/kg)	<u>Ground water</u> (mg/L)
GRO	220	39	0.500	450	150	0.500
DRO	2,000	3,000	0.500	20,000	15,000	0.720
Benzene	15.9	0.168	0.005	28.2	0.168	0.005

Tier 3 analysis involves collecting the necessary data, under BLM/UDOGM direction, to replace default values in the Tier 2 equations with site-specific information, which is applicable to Cleanup Level II Sensitivity criteria (see Attachment 5, Soil Cleanup Levels tab).

Utah Non-hazardous E&P Exempt Waste Revised Leachate Test Procedure

SCOPE AND APPLICATION

This test method is designed to simulate water leach effects on salt and oil contaminated soils and pit waste deposited from drilling and producing operations that have been solidified with cementitious materials and/or fly ash. This test shows if the contaminants have been adequately immobilized.

SUMMARY OF METHOD

A representative sample of fluid is extracted after continuous contact of the solid waste with water, at a 1:4 solid/solution ratio, for 18 hours with the flask contents swirled to effect gentle intermittent agitation. A suitable aliquot of the extract is analyzed for chlorides and total dissolved solids (TDS) with the remainder of the sample partitioned for total petroleum hydrocarbon (TPH) determination. Solidified waste materials are fractured to pass a ¾ inch sieve before extraction.

SAMPLE PREPARATION

Solidified materials are fractured to pass a ¾ inch sieve. Moisture determinations are made for representative aggregate to correct for interstitial water in preparing the 1:4 solid/solution test matrix. If the sample is at or above this ratio, do not add additional water.

PROCEDURE

Weigh 100 grams (dry weight basis) prepare sample into a 1,000 ml or larger glass container.

Add ASTM Type II deionized water as required to adjust solution volume to a 1:4 solids to liquid ratio. Stopper and swirl the contents of the flask to start 18 hours of contact time

at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$

The sample extract is then separated from the solids. A non-filtered aliquot of the extract is analyzed for TPH using EPA modified method 418.1, method 8015 extended range, or any other suitable EPA approved method. The TPH method should be determined based on the type of oil in the sample. Be careful to recover and measure any hydrocarbon sticking to the sides of the container. Dissolved solids measurement is noted below.

Filtered extract chloride and TDS values are determined using EPA Method SW-846 9056/9253 and EPA methods 160.1 and 120.1, respectively. Method 120.1 determines the fluid electrical conductivity, (EC). The EC values should be converted to equivalent TDS mg/L values with appropriate temperature adjustments.

PIT FIXATION SAMPLE TESTING GUIDANCE

Approval of pit treatment requires accomplishment of one or more of the following items:

- (1) Compressive strengths achieved to accommodate post drilling or production activities.
- (2) The weight or volume of waste reduced.
- (3) Harmful properties of the waste reduced or removed.
- (4) The mobility of leachate constituents effectively reduced or eliminated.

The closure report and the chemical analyses should support the treatment objective. The reportable contaminants are salt, specifically chlorides, TDS, and oil, specifically TPH. There should be two samples. A pretreatment sample and a post treatment (solidified sample only).

Determine the pretreated sample TPH using EPA method 8015 modified, EPA method 418.1 or any previously approved method that determines the sample oil weight or volume percent. Determine the pretreated sample fluid extract TDS by using EPA methods 160.1 or 120.1. If method 120.1 is used, the electrical conductivity, (EC), of the sample filtrate is multiplied by 0.64 at 25N C to determine the calculated TDS.

Use the Utah Modified Leachate test on the post treatment sample. This test measures the effectiveness of oil and salt mobility reduction. The TPH content of the treated pit sample leachate is determined by using EPA method 418.1 or EPA method 8015 modified extended range for soils. The allowable leachate TPH for treated material is 10 mg/l or less.

Sample fluid extract TDS is determined by using EPA methods 160.1 or 120.1. If method 120.1 is used, the electrical conductivity, (EC), of the sample filtrate is multiplied by 0.64 at 25N C to determine the TDS. An EC reading of 7800 Mhos/cm at 25N C is equivalent to a TDS value of 5000 mg/l. If the TDS exceeds 5000 mg/l, determine the extract anions and cations. TDS (in mg/L) = $EC_{\text{water}} \text{ (in dS/m)} \times 640$, where 1 ds = 1 mmho/cm.

REFERENCES

Wyoming Oil and Gas Conservation Commission, *Wyoming Oil & Gas Conservation Commission Soil and Sludge Sample Guide*, (c) Wyoming Oil & Gas Conservation Commission Nonhazardous E&P Exempt Waste Revised Leachate Test Procedure

Louisiana Department of Natural Resources, Office of Conservation, Injection and Mining Division, *Laboratory Procedures for Analysis of Exploration & Production Waste*, Leachate Test

Utah Department of Environmental Quality, Division of Environmental Response and Remediation (DERR), A Summary of Groundwater and Soil Cleanup Screening Levels, November 1, 2005

Utah Department of Environmental Quality,
Division of Water Quality Hydrocarbon Thresholds

Initial Screening Levels
November 1, 2005

Contaminants*	Groundwater (mg/L)	Soil (mg/kg)
Benzene	0.005	0.2
Toluene	1.0	9
Ethylbenzene	0.7	5
Xylenes	10.0	142
Naphthalene	0.7	51
Methyl t-butyl ether (MTBE)	0.2	0.3
Total Petroleum Hydrocarbons (TPH) as gasoline	1	150
Total Petroleum Hydrocarbons (TPH) as diesel	1	500
Oil and Grease or Total Recoverable Petroleum Hydrocarbons (TRPH)	10	1000

Tier 1 Screening Criteria
November 1, 2005

Tier 1 Screening Levels are applicable only when the following site conditions are met:

- 1.) No buildings, property boundaries or utility lines within 30 feet of the highest measured concentration of any contaminant that is greater than the initial screening levels but less than or equal to the Tier 1 screening levels AND,*
- 2.) No water wells or surface water within 500 feet of highest measured concentration of any contaminant that is greater than the initial screening levels but less than or equal to the Tier 1 screening levels.*

Contaminants *	Groundwater (mg/L)	Soil (mg/kg)
Benzene	0.3	0.9
Toluene	3	25
Ethylbenzene	4	23
Xylenes	10	142
Naphthalene	0.7	51
Methyl t-butyl ether (MTBE)	0.2	0.3
Total Petroleum Hydrocarbons (TPH) as gasoline	10	1500
Total Petroleum Hydrocarbons (TPH) as diesel	10	5000
Oil and Grease or Total Recoverable Petroleum Hydrocarbons (TRPH)	10	10000

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

		Residential Scenario							Non-residential Scenario				Soil Saturation		
Contaminant	CAS No.	Soil Pathway		Groundwater		Soil-to-Gw		Indoor air	Soil Pathway		Groundwater		Soil-to-Gw	mg/kg	
		mg/kg		mg/L		mg/kg		ug/m ³	mg/kg		mg/L		mg/kg		
Acenaphthene	83-32-9	3420	ns	0.253	n	255		219	n	30600	ns	0.521	n	526	196
Acetochlor	34256-82-1	1220	ns	0.303	n	19.3				17600	ns	1.96	n	125	688
Acetone	67-64-1	50300	n	11.5	n	51.6		32300	n	406000	ns	45.5	n	204	124000
Acetophenone	98-86-2	5200	ns	0.494	n	7.1		365	n	31300	ns	0.926	n	13.3	3790
Acrolein	107-02-8	0.192	n	4.15E-05	n	0.000175		0.0209	n	0.27	n	5.83E-05	n	0.000246	23500
Acrylamide	79-06-1	15.9	c	0.0017	c	0.00874				49.3	c	0.00571	c	0.0294	61200
Acrylonitrile	107-13-1	3.18	c	0.000491	c	0.0028		0.358	c	5.93	c	0.000978	c	0.00559	13900
Alachlor (Lasso)	15972-60-8	142	c	0.002	m	0.133				440	c	0.002	m	0.133	774
Aldicarb (Temik)	116-06-3	61.1	n	0.0156	n	0.139				881	n	0.102	n	0.906	2090
Aldrin	309-00-2	0.468	c	4.95E-05	c	0.812				1.45	c	0.000166	c	2.73	13.9
Anthracene	120-12-7	18000	ns	1.15	n	3770		1100	n	221000	ns	2.5	n	8180	7.1
Antimony	7440-36-0	31.3	n	0.006	m					817	n	0.006	m		
Arsenic	7440-38-2	11.3	c	0.01	m					38	c	0.01	m		
Atrazine	1912-24-9	34.6	c	0.003	m	0.147				107	cs	0.003	m	0.147	81.4
Barium	7440-39-3	15300	n	2	m					277000	n	2	m		
Bentazon	25057-89-0	1830	ns	0.462	n	2.77				26400	ns	3	n	18	100
Benzene	71-43-2	15.9	c	0.005	m	0.168		3.12	c	28.2	c	0.005	m	0.168	2870
Benzidine	92-87-5	0.0346	c	3.67E-06	c	0.000887				0.107	c	1.23E-05	c	0.00298	3860
Benzo(a)anthracene	56-55-3	10.9	c	0.000223	c	7.89				33.8	cs	0.00075	c	26.5	16.6
Benzo(b)fluoranthene	205-99-2	10.9	cs	0.00016	c	19.2				33.8	cs	0.000537	c	64.4	8.99
Benzo(k)fluoranthene	207-08-9	109	cs	0.00162	c	190				338	cs	0.00543	c	638	4.7
Benzo(a)pyrene	50-32-8	1.09	c	0.0002	m	23.5				3.38	c	0.0002	m	23.5	9.52
Benzyl Chloride	100-44-7	14.6	c	0.000817	c	0.0762		0.497	c	28.5	c	0.00151	c	0.14	2400
Beryllium	7440-41-7	155	n	0.004	m					3650	n	0.004	m		
Bis(2-chloroethyl)ether	111-44-4	2.92	c	0.000124	c	0.00129		0.0737	c	6.01	c	0.000226	c	0.00236	7260
Bis(chloromethyl)ether	542-88-1	0.00102	c	6.52E-07	c	4.07E-06		0.000392	c	0.00174	c	1.20E-06	c	7.48E-06	5070
Bis(2-ethylhexyl)phthalate	117-81-7	569	cs	0.006	m	144				1760	cs	0.006	m	144	323
Bromacil	314-40-9	6110	ns	1.55	n	26.9				88100	ns	10.1	n	175	79.3
Bromodichloromethane	75-27-4	3.93	c	0.08	m	0.841		0.658	c	6.69	c	0.08	m	0.841	1320
Bromoform	75-25-2	1010	c	0.08	m	0.832				3120	cs	0.08	m	0.832	1310
Bromomethane	74-83-9	9.39	n	0.007	n	0.05		5.21	n	14.6	n	0.0132	n	0.0947	4380
1,3-Butadiene	106-99-0	0.697	c	0.000193	c	0.0033		0.811	c	1.36	c	0.000579	c	0.00992	776
Butyl Benzyl Phthalate	85-68-7	4190	cs	0.333	c	478				13000	cs	1.12	c	1610	193
Butylate	2008-41-5	3060	ns	0.576	n	46.8				44000	ns	3.44	n	279	178
n-Butylbenzene	104-51-8	285	ns	0.0338	n	10.2		36.5	n	687	ns	0.0785	n	23.6	252

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		Soil Pathway mg/kg		Groundwater mg/L		Soil-to-Gw mg/kg		Indoor air ug/m ³	Soil Pathway mg/kg		Groundwater mg/L		Soil-to-Gw mg/kg	mg/kg
sec-Butylbenzene	135-98-8	276	n	0.0305	n	8.27	36.5	n	654	ns	0.0745	n	20.2	381
Cadmium	7440-43-9	39	n	0.005	m				965	n	0.005	m		
Caprolactam	105-60-2	30600	n	7.77	n	69.2			440000	n	50.6	n	451	266000
Captan	133-06-2	3460	cs	0.366	c	19.9			10700	cs	1.23	c	67	13.4
Carbaryl (Sevin)	63-25-2	6110	ns	1.52	n	114			88100	ns	9.84	n	737	401
Carbazole	86-74-8	398	c	0.0287	c	52.7			1230	c	0.0965	c	177	1300
Carbofuran (Furadan)	1563-66-2	306	n	0.04	m	0.922			4400	ns	0.04	m	0.922	337
Carbon Disulfide	75-15-0	1020	ns	0.716	n	6.71	730	n	1680	ns	1.66	n	15.6	923
Carbon Tetrachloride	56-23-5	8.44	c	0.005	m	0.0734	4.06	n	14.7	c	0.005	m	0.0734	590
Chlordane	12789-03-6	22.7	cs	0.002	m	13.5			70.5	cs	0.002	m	13.5	18.9
Chlordecone (Kepone)	143-50-0	0.796	c	7.76E-05	c	0.272			2.47	c	0.000261	c	0.913	473
Chlorobenzene	108-90-7	380	n	0.1	m	5.1	52.1	n	740	n	0.1	m	5.1	1230
Chlorodifluoromethane	75-45-6	65400	ns	70.7	n	941	52100	n	98300	ns	132	n	1760	2040
Chloroform	67-66-3	4.22	c	0.08	m	0.85	1.06	c	7.14	c	0.08	m	0.85	3550
Chloromethane	74-87-3	146	n	0.127	n	0.924	93.9	n	223	n	0.238	n	1.73	1590
beta-Chloronaphthalene	91-58-7	4350	ns	0.344	n	172	292	n	30900	ns	0.7	n	350	291
o-Chlorotoluene	95-49-8	542	n	0.0889	n	7.18	73	n	1270	n	0.178	n	14.3	1480
Chlorpyrifos (Lorsban/Dursban)	2921-88-2	183	ns	0.0385	n	56.2			2640	ns	0.236	n	344	81.7
Chromium (total)	18540-29-9	33.6	c	0.1	m				111	c	0.1	m		
Chrysene	218-01-9	1090	cs	0.0223	c	805			3380	cs	0.075	c	2710	3.61
Cobalt	7440-48-4	23.4	n	0.00468	n				579	n	0.0306	n		
Copper	7440-50-8	3130	n	1.3	m				81700	n	1.3	m		
Cumene	98-82-8	2540	ns	0.451	n	65.1	417	n	5680	ns	0.968	n	140	439
Cyanazine (Bladex)	21725-46-2	9.47	c	0.000995	c	0.0307			29.4	c	0.00334	c	0.103	245
Cyanide	57-12-5	1560	n	0.2	m				40900	n	0.2	m		
Dacthal	1861-32-1	611	ns	0.142	n	15.1			8810	ns	0.9	n	95.6	2.61
DDD	72-54-8	33.2	c	0.00135	c	31.8			103	c	0.00455	c	107	106
DDE	72-55-9	23.4	c	0.00103	c	24.1			72.5	cs	0.00345	c	81.1	47
DDT	50-29-3	23.4	cs	0.00073	c	24.6			72.5	cs	0.00245	c	82.8	9.27
Diazinon	333-41-5	42.8	n	0.0102	n	6.26			617	n	0.0654	n	40	1220
Dibenzo(a,h)anthracene	53-70-3	1.09	c	8.05E-06	c	3.08			3.38	c	2.70E-05	c	10.3	47.6
Dibenzofuran	132-64-9	58.2	n	0.00413	n	7.59	3.65	n	579	ns	0.0086	n	15.8	284
1,4-Dibromobenzene	106-37-6	611	ns	0.135	n	10.7			8810	ns	0.837	n	66.3	77.2
Dibromochloromethane	124-48-1	94.7	c	0.08	m	0.834			294	c	0.08	m	0.834	1150
1,2-Dibromo-3-chloropropane	96-12-8	9.93	c	0.0002	m	0.00543			30.7	c	0.0002	m	0.00543	1550

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Dibutyl Phthalate	84-74-2	6110	ns	1.35	n	318				88100	ns	8.4	n	1980	131
Dicamba	1918-00-9	1830	n	0.461	n	4.52				26400	ns	2.99	n	29.4	3240
1,2-Dichlorobenzene	95-50-1	2340	ns	0.6	m	48.4	209	n		5340	ns	0.6	m	48.4	615
1,4-Dichlorobenzene	106-46-7	37.5	c	0.075	m	5.94	2.21	c		63.7	c	0.075	m	5.94	315
Dichlorodifluoromethane	75-71-8	227	n	0.366	n	13.5	209	n		323	n	0.567	n	21	883
1,1-Dichloroethane	75-34-3	46.8	c	0.025	c	0.269	15.2	c		79.9	c	0.0461	c	0.496	2320
1,2-Dichloroethane	107-06-2	6.27	c	0.005	m	0.06	0.936	c		10.9	c	0.005	m	0.06	4340
1,1-Dichloroethylene	75-35-4	313	n	0.007	m	0.0859	209	n		484	n	0.007	m	0.0859	1510
cis-1,2-Dichloroethylene	156-59-2	115	n	0.07	m	0.855	36.5	n		194	n	0.07	m	0.855	3380
trans-1,2-Dichloroethylene	156-60-5	202	n	0.1	m	1.22	62.6	n		333	n	0.1	m	1.22	2390
2,4-Dichlorophenol	120-83-2	183	n	0.0412	n	4.22				2640	n	0.258	n	26.4	22600
4-(2,4-Dichlorophenoxy)butyric acid	94-82-6	489	ns	0.115	n	2.71				7050	ns	0.727	n	17.2	49.9
2,4-Dichlorophenoxyacetic acid	94-75-7	611	ns	0.07	m	0.695				8810	ns	0.07	m	0.695	268
1,2-Dichloropropane	78-87-5	12.9	c	0.005	m	0.0817	2.43	c		22.3	c	0.005	m	0.0817	2040
1,3-Dichloropropene	542-75-6	23.3	c	0.0049	c	0.0916	6.08	c		45.2	c	0.0117	c	0.219	2380
Dichlorvos	62-73-7	27.4	c	0.00291	c	0.0431				85.1	c	0.00979	c	0.145	5120
Dieldrin	60-57-1	0.497	c	4.80E-05	c	0.193				1.54	c	0.000161	c	0.649	39.2
Diethyl Phthalate	84-66-2	48900	ns	12.2	n	305				705000	ns	79	n	1970	1240
2,4-Dimethylphenol	105-67-9	1220	n	0.292	n	29.9				17600	n	1.86	n	190	39500
Dimethylphthalate	131-11-3	611000	ns	155	n	1600				8810000	ns	1010	n	10400	3100
2,4-Dinitrophenol	51-28-5	122	n	0.031	n	2.98				1760	n	0.202	n	19.4	13100
2,4-Dinitrotoluene	121-14-2	25.7	c	0.00267	c	0.318				79.6	c	0.00898	c	1.07	1170
2,6-Dinitrotoluene	606-20-2	61.1	n	0.0154	n	1.87				881	n	0.1	n	12.2	900
Di-n-octyl Phthalate	117-84-0	1220	ns	0.0184	n	518				17600	ns	0.0894	n	2520	0.649
1,4-Dioxane	123-91-1	723	c	0.0772	c	0.349				2240	c	0.259	c	1.17	126000
Dioxin (2,3,7,8-TCDD)	1746-01-6	6.11E-05	c	3.00E-08	m	0.00149				0.00019	c	3.00E-08	m	0.00149	0.498
Diphenylamine	122-39-4	1530	ns	0.314	n	53.1				22000	ns	1.91	n	324	443
Diuron	330-54-1	122	ns	0.0304	n	0.784				1760	ns	0.196	n	5.07	50
Endosulfan	115-29-7	367	ns	0.0921	n	125				5290	ns	0.598	n	811	22
Endrin	72-20-8	18.3	n	0.002	m	8.04				264	ns	0.002	m	8.04	50.3
Ethyl Chloride	75-00-3	18200	ns	14	n	128	10400	n		28100	ns	26.4	n	241	2690
s-Ethyl Dipropylthiocarbamate (EPTC)	759-94-4	1410	ns	0.12	n	4.41	91.3	n		11700	ns	0.229	n	8.43	653
Ethylbenzene	100-41-4	82	c	0.7	m	65.6	9.73	c		145	c	0.7	m	65.6	781
Ethylene Dibromide	106-93-4	0.483	c	5.00E-05	m	0.000598	0.0406	c		0.859	c	5.00E-05	m	0.000598	1960
Ethylene Glycol	107-21-1	122000	ns	31.3	n	131				1760000	ns	204	n	858	110000

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

Contaminant	CAS No.	Residential Scenario							Non-residential Scenario				Soil Saturation	
		Soil Pathway mg/kg		Groundwater mg/L		Soil-to-Gw mg/kg		Indoor air ug/m ³	Soil Pathway mg/kg		Groundwater mg/L		Soil-to-Gw mg/kg	mg/kg
Fluoranthene	206-44-0	2440	ns	0.255	n	2830			35200	ns	1.37	n	15200	144
Fluorene	86-73-7	2360	ns	0.162	n	297	146	n	25900	ns	0.341	n	626	155
Fonofos (Dyfonate)	944-22-9	122	n	0.0266	n	4.65			1760	ns	0.164	n	28.8	136
Formaldehyde	50-00-0	175	c	0.0184	c	0.0774			542	c	0.0619	c	0.26	44000
Furan	110-00-9	12.4	n	0.00493	n	0.1	3.65	n	21.3	n	0.00925	n	0.189	9410
Glyphosate (Roundup)	1071-83-6	6110	ns	0.7	m	2.94			88100	ns	0.7	m	2.94	1160
Heptachlor	76-44-8	1.77	c	0.0004	m	3.3			5.48	c	0.0004	m	3.3	74.3
Heptachlor Epoxide	1024-57-3	0.794	n	0.0002	m	0.405			2.71	c	0.0002	m	0.405	20.2
Hexachlorobenzene	118-74-1	4.97	cs	0.001	m	1.24			15.4	cs	0.001	m	1.24	0.385
Hexachlorobutadiene	87-68-3	61.1	ns	0.00632	c	1.1			316	ns	0.0212	c	3.69	27.6
gamma-Hexachlorocyclohexane (Lindane)	58-89-9	7.24	c	0.0002	m	0.113			22.4	c	0.0002	m	0.113	206
Hexachlorocyclopentadiene	77-47-4	366	ns	0.05	m	14.3			5210	ns	0.05	m	14.3	25.8
Hexachloroethane	67-72-1	61.1	n	0.0131	n	0.57			881	ns	0.0805	n	3.51	105
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	72.4	cs	0.00772	c	0.168			224	cs	0.0259	c	0.566	59.1
n-Hexane	110-54-3	656	ns	0.316	n	50.1	730	n	1100	ns	1.06	n	167	145
Hydrazine	302-01-2	5.67	c	0.000134	c				19	c	0.000876	c		
Hydrazine Sulfate	10034-93-2	5.67	c	0.000284	c				19	c	0.000953	c		
Indeno(1,2,3-cd)pyrene	193-39-5	10.9	cs	0.000117	c	45.5			33.8	cs	0.000392	c	153	3.71
Lead	7439-92-1	400	k	0.015	m				1000	k	0.015	m		
Malathion	121-75-5	1220	ns	0.311	n	3.19			17600	ns	2.03	n	20.8	59
Manganese	7439-96-5	9300	n	0.05	M				66200	n	0.05	M		
Mercury	7439-97-6	2	k	0.002	m				20	k	0.002	m		
Methoxychlor	72-43-5	306	ns	0.04	m	215			4400	ns	0.04	m	215	26.9
Methyl Ethyl Ketone	78-93-3	26000	n	4.92	n	24.2	5210	n	101000	ns	11.8	n	57.8	32500
Methyl Isobutyl Ketone	108-10-1	4450	ns	1.02	n	6.69	3130	n	34800	ns	4.17	n	27.2	4310
Methyl tert-Butyl Ether	1634-04-4	585	c	0.133	c	0.848	93.6	c	1050	c	0.262	c	1.66	11200
Methylene Chloride	75-09-2	149	c	0.005	m	0.0429	51.8	c	267	c	0.005	m	0.0429	4440
2-Methylnaphthalene	91-57-6	209	n	0.0167	n	8.34	14.6	n	1280	ns	0.0346	n	17.3	612
2-Methylphenol	95-48-7	3060	n	0.744	n	48.6			44000	n	4.78	n	312	82000
3-Methylphenol	108-39-4	3060	n	0.744	n	47.7			44000	n	4.77	n	306	70500
4-Methylphenol	106-44-5	306	n	0.0744	n	4.77			4410	n	0.478	n	30.6	66700
Metolachlor (Dual)	51218-45-2	9170	ns	2.3	n	233			132000	ns	14.9	n	1510	2640
Metribuzin (Sencor)	21087-64-9	1530	ns	0.388	n	5.67			22000	ns	2.53	n	36.9	663
Naphthalene	91-20-3	30.5	c	0.00111	c	0.349	0.716	c	64.7	c	0.00211	c	0.659	482
Nickel	7440-02-0	1540	n	0.312	n				32400	n	2.04	n		

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

		Residential Scenario							Non-residential Scenario				Soil Saturation		
Contaminant	CAS No.	Soil Pathway		Groundwater		Soil-to-Gw		Indoor air	Soil Pathway		Groundwater		Soil-to-Gw	mg/kg	
		mg/kg		mg/L		mg/kg		ug/m ³	mg/kg		mg/L		mg/kg		
Nitrobenzene	98-95-3	32.2	c	0.00101	c	0.0496		0.608	c	72.9	c	0.00185	c	0.0912	4940
Nitrofurazone	59-87-0	6.12	c	0.000654	c	0.0484				19	c	0.0022	c	0.163	755
Nitroguanidine	556-88-7	6110	ns	1.56	n	12.7				88100	ns	10.2	n	83	1350
2-Nitropropane	79-46-9	0.151	c	1.50E-05	c	0.000153		0.00901	c	0.276	c	2.75E-05	c	0.00028	6950
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691-41-0	3060	ns	0.782	n	86.3				44000	ns	5.11	n	564	27.1
Oxamyl	23135-22-0	1530	n	0.2	m	1.2				22000	n	0.2	m	1.2	56000
Paraquat	1910-42-5	275	n	0.0704	n	95.7				3960	n	0.46	n	625	47500000
Parathion	56-38-2	367	ns	0.0864	n	42.2				5290	ns	0.549	n	268	268
Pendimethalin (Prowl)	40487-42-1	2440	ns	0.356	n	401				35200	ns	2.01	n	2260	16.9
Pentachlorophenol	87-86-5	66.3	c	0.001	m	0.996				206	c	0.001	m	0.996	696
Perchlorate	7790-98-9	54.7	n	0.0109	n	0.0435				1430	n	0.0709	n	0.284	
Permethrin (Ambush)	52645-53-1	3060	ns	0.33	n	7830				44000	ns	1.78	n	42300	7.13
Phenol	108-95-2	18300	n	4.56	n	189				264000	ns	29.5	n	1220	163000
Phenylphenol	90-43-7	4190	c	0.381	c	514				13000	c	1.28	c	1730	47100
Phosphine	7803-51-2	23.5	n	0.00466	n					612	n	0.0304	n		
Picloram (Tordon)	1918-02-1	4280	ns	0.5	m	5.88				61700	ns	0.5	m	5.88	210
Profluralin	26399-36-0	367	ns	0.0589	n	360				5290	ns	0.339	n	2070	30.5
Prometon	1610-18-0	917	n	0.222	n	7				13200	ns	1.43	n	44.9	1110
Propachlor (Ramrod)	1918-16-7	794	n	0.2	n	8.96				11500	ns	1.3	n	58.2	1240
Propazine (Miloguard)	139-40-2	1220	ns	0.299	n	21.8				17600	ns	1.92	n	140	30.5
n-Propylbenzene	103-65-1	4070	ns	0.66	n	110		1040	n	14300	ns	1.91	n	320	434
Pyrene	129-00-0	1830	ns	0.202	n	2190				26400	ns	1.09	n	11900	73.4
Pyridine	110-86-1	51.5	n	0.00496	n	0.091		3.65	n	301	n	0.00928	n	0.17	817000
Selenium	7782-49-2	391	n	0.05	m					10200	n	0.05	m		
Silver	7440-22-4	391	n	0.0779	n					10200	n	0.508	n		
Simazine (Princap)	122-34-9	66.3	cs	0.004	m	0.133				206	cs	0.004	m	0.133	9.7
Styrene	100-42-5	7020	ns	0.1	m	9.34		1040	n	20400	ns	0.1	m	9.34	1420
Terbacil (Sinbar)	5902-51-2	794	ns	0.201	n	2.82				11500	ns	1.31	n	18.3	427
Terbufos (Counter)	13071-79-9	1.53	n	0.000316	n	0.0645				22	n	0.00193	n	0.394	51.2
Tert-butyl Alcohol	75-65-0	2410	c	0.256	c	1.13				7470	c	0.859	c	3.8	18300
1,1,1,2-Tetrachloroethane	630-20-6	27.8	c	0.00535	c	0.114		3.29	c	48.8	c	0.00991	c	0.212	1050
1,1,2,2-Tetrachloroethane	79-34-5	8.21	c	0.000694	c	0.016		0.42	c	15.2	c	0.00128	c	0.0294	2980
Tetrachloroethylene	127-18-4	7.54	c	0.005	m	0.121		4.12	c	16.5	c	0.005	m	0.121	244
2,3,4,6-Tetrachlorophenol	58-90-2	1830	ns	0.32	n	191				26400	ns	1.87	n	1120	685
Tetryl	479-45-8	244	n	0.0624	n	57.7				3520	ns	0.407	n	377	3420

APPENDIX A - KDHE TIER 2 RISK-BASED SUMMARY TABLE

Contaminant	CAS No.	Residential Scenario							Non-residential Scenario					Soil	
		Soil Pathway		Groundwater		Soil-to-Gw		Indoor air	Soil Pathway		Groundwater		Soil-to-Gw	Saturation	
		mg/kg		mg/L		mg/kg		ug/m ³		mg/kg		mg/L	mg/kg	mg/kg	
Toluene	108-88-3	4320	ns	1	m	51.2		5210	n	29800	ns	1	m	51.2	1310
Total Petroleum Hydrocarbons (GRO)		220	k	0.5	k	79.3				450	k	0.5	k	79.3	3300
Total Petroleum Hydrocarbons (DRO)		2000	k	0.5	k	5440				20000	k	0.72	k	7830	70000
Toxaphene	8001-35-2	7.24	cs	0.003	m	46.3				22.4	cs	0.003	m	46.3	5.38
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	13800	ns	3.94	n	321		31300	n	60000	ns	20.3	n	1660	1050
1,2,4-Trichlorobenzene	120-82-1	89.2	n	0.07	m	19.3		2.09	n	144	n	0.07	m	19.3	670
1,1,1-Trichloroethane	71-55-6	11800	ns	0.2	m	2.8		5210	n	18100	ns	0.2	m	2.8	864
1,1,2-Trichloroethane	79-00-5	15.6	c	0.005	m	0.081		1.52	c	27.6	c	0.005	m	0.081	3270
Trichloroethylene	79-01-6	41	c	0.005	m	0.0842		12.2	c	69.8	c	0.005	m	0.0842	1000
Trichlorofluoromethane	75-69-4	1000	n	1.09	n	21.5		730	n	1470	ns	1.9	n	37.5	1410
2,4,5-Trichlorophenol	95-95-4	6110	n	1.26	n	454				88100	ns	7.71	n	2770	21400
2,4,6-Trichlorophenol	88-06-2	61.1	n	0.0127	n	4.57				881	n	0.0777	n	27.9	14300
2,4,5-Trichlorophenoxyacetic Acid	93-76-5	611	ns	0.148	n	3.75				8810	ns	0.944	n	24	325
2,4,5-Trichlorophenoxypropionic acid	93-72-1	489	ns	0.05	m	1.95				7050	ns	0.05	m	1.95	132
1,2,3-Trichloropropane	96-18-4	0.0576	c	4.68E-06	c	0.000127		0.00284	c	0.107	c	8.62E-06	c	0.000234	2210
Trifluralin (Treflan)	1582-09-8	458	ns	0.0668	c	219				3200	ns	0.225	c	737	30.2
1,2,4-Trimethylbenzene	95-63-6	54	n	0.00844	n	1.07		7.3	n	126	n	0.0174	n	2.21	359
1,3,5-Trimethylbenzene	108-67-8	243	n	0.044	n	5.51		36.5	n	530	ns	0.0884	n	11.1	298
2,4,6-Trinitrotoluene	118-96-7	30.6	n	0.00777	n	4.4				440	n	0.0507	n	28.7	3250
Vinyl Acetate	108-05-4	1260	n	0.406	n	2.09		209	n	1800	n	0.581	n	2.99	3200
Vinyl Chloride	75-01-4	4.47	c	0.002	m	0.0205		5.53	c	9.21	c	0.002	m	0.0205	4600
Xylene (mixed isomers)	1330-20-7	936	ns	10	m	809		104	n	1410	ns	10	m	809	421
Zinc	7440-66-6	23500	n	4.67	n					613000	n	30.5	n		

Notes

n = The value is based on non-carcinogenic health risk, with a hazard index (HI) = 1.

c = The value is based on carcinogenic health risk with a target cancer risk of 10E-5.

ns or cs = The value is based upon health risk; however, the calculated saturation value is lower than the health risk value presented.

k = KDHE has established this value by means other than the equations in this manual.

m = The groundwater value is equal to the EPA MCL.

M = The groundwater value is equal to the EPA Secondary MCL.

Tier 2 Indoor Air values are presented in ug/m³, which may be converted to parts per billion volume (ppbv) using the equation:

$$\text{Tier 2 value (ug/m}^3\text{)} \times 24 / \text{contaminant molecular weight (MW from App B)} = \text{concentration (ppbv)}$$